understood that the terms "include/comprise" and/or "have" when used in this specification, specify the presence of stated features, integers, steps, operations, elements, components, and/or combinations thereof, but do not preclude the presence or addition of one or more other features, numbers, steps, operations, elements, components, and/or groups thereof.

[0034] Unless otherwise defined, all terms including technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which examples belong. It will be further understood that terms, such as those defined in commonly-used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0035] FIG. **1** is a diagram illustrating an example of a difference between an amount of light incident to an eye in a surrounding environment and an amount of light incident to an eye from a display according to one or more embodiments.

[0036] As noted above, there may be occasions when adjustments of image brightness are implemented to compensate for limitations of an underlying display, to provide the viewer an accurate image that is identical to the original stored or transmitted image. However, as discussed below, there may be alternatively or additionally occasions when adjustment of the image brightness are implemented, e.g., through either or both of adjustment of the image before display and adjustment of pixel brightness, to differentiate the displayed image from its original stored or transmitted image, or to differentiate select portions of the original stored or transmitted image, such as when a physiological response of changes in an image or a viewed portion of the image may be considered to provide a sense of reality and actuality to the viewer.

[0037] For example, as illustrated in FIG. **1**, a substantial difference between light intensity incident to an eye **110** of a human body in an actual environment **120** and a display light intensity incident to the eye **110** from an electronic device **130** may exist. Hereinafter, an eye of a human body is referred to as an eye. For example, in the actual environment **120**, light of approximately 100,000 lux may be incident to the eye **110** viewing the actual environment **120** in sunny weather. Conversely, the display light intensity emitted from a display included in the electronic device **130**, for example, a television (TV) and a smartphone, may be less than approximately one tenth of the actual light intensity. Therefore, a user viewing the display may determine an apparent brightness level of an object represented on the display based on a color of the display rather than the display light intensity.

[0038] For example, an underexposure or an overexposure by a light intensity may partially occur in an image photographed in an area having a relatively high brightness or an area having a relatively low brightness, respectively. Correspondingly, a sense of reality and actuality could be sensed by the eye **110** if provided higher or lower brightnesses that mimic such overexposures or underexposures.

[0039] FIG. **2** is a graph illustrating an example of a physiological change or response in a visual cell sensitivity with respect to a change of light in an eye of a human body in accordance with an embodiment.

[0040] An eye requires an amount of time for adapting or acclimating in response to the eye instantly viewing a region having a relatively high brightness or a region having a relatively low brightness. For example, in response to the eye viewing the region having a relatively high brightness, a visual field may be gradually obtained subsequent to sensing glare, i.e., as the eye gradually becomes more accustomed to the sensed glare. Conversely, in response to the eye viewing the region having a relatively low brightness, the visual field may be gradually obtained subsequent to sensing darkness, i.e., as the eye gradually becomes more accustomed to the sensed darkness. FIG. **2** illustrates the visual cell sensitivity in response to the eye viewing the region having a relatively low brightness.

[0041] As illustrated in FIG. **2**, the visual cell sensitivity may drastically change twice, or may occur through two phases or regions. The change of the visual cell sensitivity may occur due to a physiological difference between a cone cell and a rod cell, and the visual field may be obtained as time elapses. For example, as illustrated in FIG. **2**, a human body may adapt to an instant strong light or darkness thereby obtaining the substantial visual field after a predetermined point in time **210**. An adaptation to strong light refers to a light reaction, and an adaptation to darkness refers to a dark reaction. For example, the predetermined point in time **210** allowed for the eye to adapt to the strong light or darkness and obtain the visual field may be less than one minute.

[0042] In terms of a brightness having an identical intensity, the eye may recognize the brightness of a displayed image to be relatively low when viewed in an environment where a periphery has a relatively high brightness, and the eye may recognize the brightness of the displayed image to be relatively high when the periphery has a relatively low brightness. For example, the eye may further recognize a brightness of a current viewpoint or area of the displayed image by inferring the brightness based on a difference in contrast with periphery regions of the displayed image and the brightness of the current viewpoint or area of the displayed image.

[0043] In one or more embodiments, the brightness of the display may be exaggerated and represented by using the aforementioned physiological features or responses of the eye, such that a user may experience a realistic image through an instant brightness change and a difference in contrast with a relative brightness of the periphery.

[0044] FIGS. **3** and **4** are flowcharts illustrating methods of adjusting a brightness of a display, respectively, in accordance with one or more embodiments.

[0045] FIG. **3** illustrates an example of the method of adjusting the brightness of the display. In operation **310**, a processor of a device calculates viewpoint brightness information on a viewpoint region corresponding to a viewpoint of a user for an image on a display, such as a stored, transmitted, or a rendered image. Hereinafter, such a device for adjusting a brightness of a display will be simply referred to as a display brightness adjusting device. In an embodiment, the display brightness adjusting device may be a device that includes the display, or the display may be separate in a corresponding system.

[0046] A current timing refers to a timing corresponding to a present displaying operation. In an example, the current timing is referred to as a current frame in response to an image corresponding to a video including a plurality of frames. In another example, the current timing indicates a